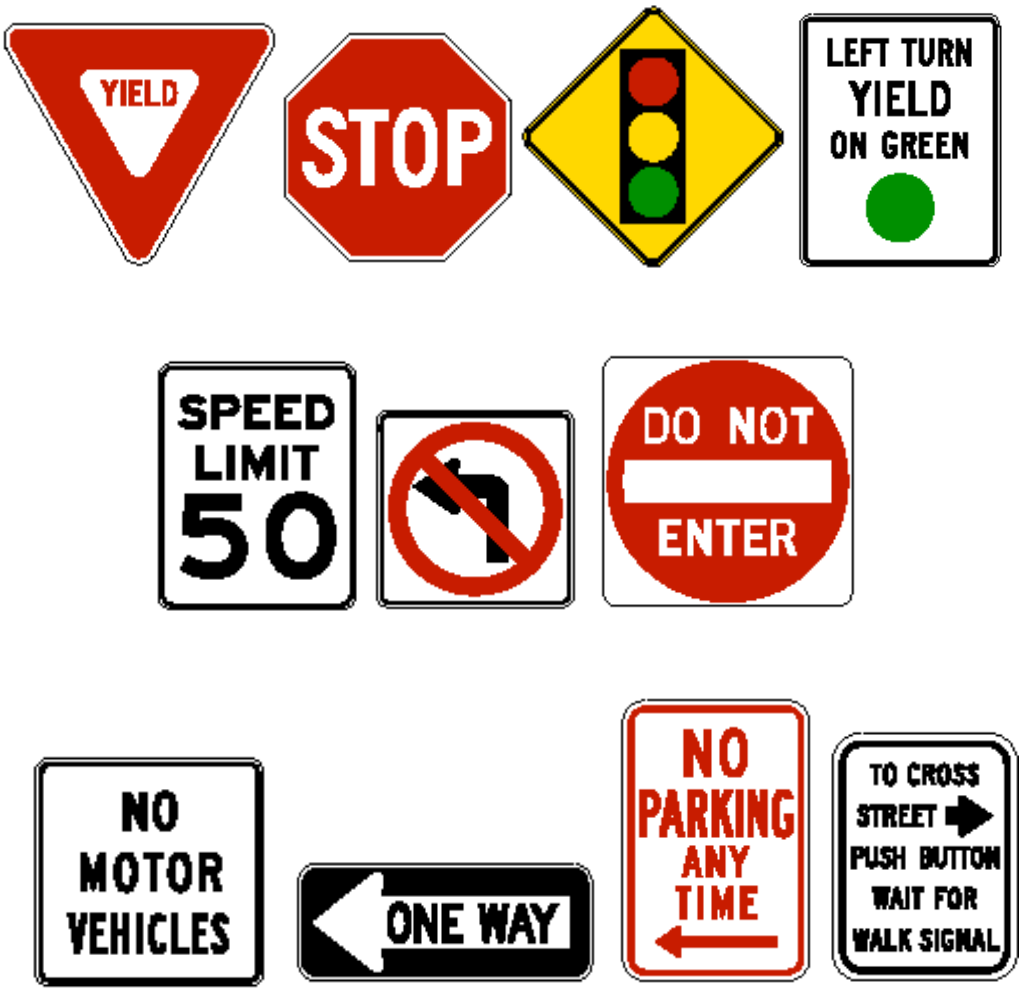
RIDOT
Traffic Design Manual

(Rhode Island DOT's Preferences and Practices)



Rhode Island Department of Transportation
Traffic Design Section
October 2004

Disclaimer:

This Manual is meant to aid those unfamiliar with RIDOT Traffic Engineering practices in accessing applicable standards, policies, and procedures. The material contained herein is for informational purposes only. It is in no way meant to supersede RIDOT Standard Specifications, Standard Details, or Design Policy Memos (DPMs).

If you have any questions or comments on the contents, format, or wording of this document please submit them to the State Traffic Engineer.

Frank Corrao III, P.E.
State Traffic Engineer
Rhode Island Department of Transportation
Two Capital Hill
Providence, RI 02903
Phone (401) 222-2694
FAX (401) 222-3006
Email: FCorrao@dot.state.ri.us

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CHAPTER

I. Introduction

The purpose of this manual is to provide a consolidated resource where current RIDOT policies, preferences, and practices related to traffic engineering can be found. It is to be used as a reference by designers not fully familiar with our requirements. It is not intended for this manual to be used in lieu of the Rhode Island Standard Specifications, Rhode Island Standard Details, and Design Policy Memorandums (DPMs), but in conjunction with them. References to applicable sections of these and other resources are made throughout this manual.

Also, this design manual is meant to be an online manual, which can be periodically updated, as our policies and practices evolve. Comments on its content, wording, and format are encouraged.

Please note that this manual applies not just to Traffic Design projects but to all RIDOT Projects

1.0 Traffic Impact and Access Study:

{This chapter applies to Physical Alteration Permit Applications submitted by private developers}

Guidance for this chapter was obtained from the following:

- ITE Manual of Transportation Engineering Studies, latest edition
- Manual on Uniform Traffic Control Devices, latest edition
- ITE Traffic Engineering Handbook, latest edition
- ITE Trip Generation Handbook latest edition

1.1 **When Required** - Traffic Impact Studies are required when a proposed development or redevelopment will generate 100 or more added (new) vehicle trips per hour during the adjacent roadway's peak hour or the development's peak hour [Ref. 1]. Or:

- When changes are proposed in an area already suffering from congestion.
- When a traffic signal warrant is met due to the additional trips generated.
- At the judgment or discretion of RIDOT.

1.2 **Trip Generation**

1.2.1 Vehicle trips for a proposed development can be estimated by using the latest ITE Trip Generation Manual for the purpose of determining level-of-service or the effect of a proposed development on adjacent roadways.

1.2.2 Vehicle trip generation estimates used for a proposed development's traffic signal warrant analysis must be obtained by counting a fully occupied similar development in the area. A traffic signal will not be approved based on warrants met by vehicle trip projections from the Trip Generation Manual. If a similar development does not exist a request for a traffic signal will only be considered once a development is fully functioning and warrants are met based on actual vehicle counts.

1.3 **Traffic Signal Approval** – The Satisfaction of a traffic signal warrant or warrants shall not in itself justify the installation of a Traffic Control Signal [Ref. 2].

- A traffic signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.
- A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.
- A traffic control signal should not be installed unless one or more of the factors described in Chapter 4C (Section 4C.01) of the Manual on Uniform Traffic Control Devices (MUTCD) are met. **For emphasis many of the factors are re-stated below:**

- The study should consider the effects of the right-turn vehicles from the minor-street approaches.
- Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the above signal warrants.

- Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics dictate whether an approach should be considered as one lane or two lanes.

- For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians. When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Engineering study data should include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.

B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.

C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B above and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.

D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.

E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.

F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.

G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year. Accident information can be obtained through the local police department and RIDOT.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods specified in Item B of the preceding paragraph:

A. Vehicle-hours of stopped time delay determined separately for each approach.
B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue length on stop-controlled approaches.

2.0 Pavement Markings:

{This chapter applies to pavement markings on <u>all</u> RIDOT projects}

Guidance for this chapter was obtained from the following:
- RIDOT *Standard Specifications for Road and Bridge Construction*, latest edition
- *Manual on Uniform Traffic Control Devices,* latest edition

2.1 **Types of Marking Material**:

2.1.1 **Waterborne Traffic Markings (T20.03.3)** shall be used on <u>cold-planed</u> surfaces and the <u>base and binder</u> courses of <u>newly paved</u> roadways, which will be opened to traffic at the completion of each day's paving operation. It shall also be used on <u>existing</u> roadway surfaces, which are in need of re-striping but are scheduled to be repaved within a year. Due to its thickness (15 mils) this type of marking lasts longer than the temporary version.

2.1.2 **Temporary Waterborne Pavement Markings (T20.03.4)** shall be placed on the <u>final surface</u> course of <u>newly paved</u> roadways that will be opened to traffic at the completion of each day's paving operation [Ref. 3]. The relative thinness of this marking (8 mils) allows the epoxy resin pavement marking overlay to bleed through and firmly attach to the pavement.

2.1.3 **Epoxy Resin Pavement Markings (T20.03.6)** shall be placed on the final surface course of newly paved roadways no sooner than 2 weeks but no longer than 4 weeks from the completion of each days paving operation. Epoxy resin pavement markings will usually be placed over temporary waterborne pavement markings.

2.1.4 **Wet Retro-reflective Temporary Pavement Marking Tape** (White, Yellow and Blackout) shall be used in projects requiring staged construction such as bridge projects. The tape allows for relatively quick and clean changes in lane configurations such as lane shifts and closures. If the existing roadway surface is to be retained at the completion of the project, blackout tape should be used to cover the existing markings. If the existing roadway surface is to be replaced then the existing markings should be removed by grinding. Please note that the use of this type of marking requires a job specific specification.

2.1.5 **Preformed Patterned Markings (High Performance Tape)** shall be used for <u>freeway skip line</u> striping and shall be inlayed into the <u>final surface course</u> during the paving operation. Please note that the use of this type of marking requires a job specific specification.

2.2 **Pavement Marking Width**

2.2.1 **Limited Access Highways** (freeways/expressways) - All edge lines <u>and</u> skip lines should be 6 inches wide. All gore markings and other transverse markings shall be twice the long line width [Ref. 2], which is to say 12 inches.

2.2.2 **All Other Roadways -** All white edge lines and skip lines shall be 6 inches and yellow center and edge lines should be 4 inches. Transverse markings shall be 12 inches

2.3 **Pavement Marking Layout on Limited Access Roadways** - Pavement markings shall be referenced from the left edge of pavement. Where berms exist, the pavement markings shall be referenced from the inside edge of the berm. This is to ensure that the left side shoulder or offset adjacent to the high-speed lane is of constant width (see figure 2.1 below).

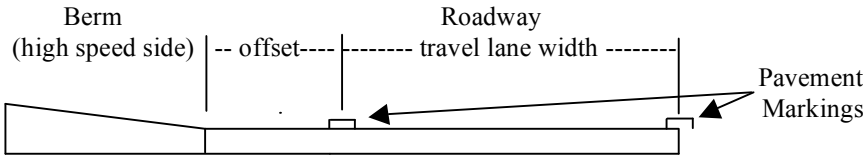


Figure 2.1

2.4 **Crosswalks** should be marked at all intersections where there is a substantial conflict between vehicular and pedestrian movements [Ref. 2]. Although crosswalks exist at all intersections, marked or unmarked, as extensions of the sidewalks across a roadway, crosswalks should <u>not be marked</u> across minor (low volume) side streets. Also, they should not be marked at mid-block locations unless an engineering study has determined they are warranted. At mid-block crossings, for added visibility and to call attention to the generally unexpected nature of such a crossings, the crosswalks should be marked with white diagonal lines at a 45-degree angle to the transverse crosswalk lines. The diagonal lines should be 12 inches wide and spaced 30 inches apart. Marked crosswalks at signalized intersections should not include diagonal or any other type of interior markings.

2.5 **Miscellaneous:**

2.5.1 **Dotted Lines** should be used for 1) line extensions, such as is necessary to guide vehicles through an intersection (i.e. between double left turning vehicles) and 2) across the entrance to a left turn lane. Although the MUTCD provides a range of gap lengths for such markings, for the purpose of consistency, they should be 2-foot line segments with 4-foot gap lengths.

2.5.2 **Freeway Gore Area Markings –** The channelizing lines at exit and entrance ramps shall be 12 inches wide. The chevron markings at exit ramps shall be 12 inches wide and shall be spaced at 20 feet or consistent with spacing of crosshatching in the area. The diagonals should be striped at a 45-degree angle to the longitudinal channelizing lines. Chevron markings should be used at exit ramps only and not at entrance ramps. Refer to MUTCD figures 3B-8 thru 3B-10 for gore area striping layouts.

2.5.3 **Median Island Markings (flush) –** The crosshatching in median islands, on all surfaces streets, shall be spaced 10 feet apart or should be consistent with crosshatching in the area. The diagonals should be striped at a 45-degree angle to the longitudinal channelizing lines.

2.5.4 **Temporary (interim) Markings -** On all roadways, including limited-access facilities, temporary pavement marking edge, center and broken lines shall only be required to be 4" wide during construction. Also, transverse markings such as Stop Bars, Crosswalks, chevrons (cross-hatching) inside temporary gores, etc. are not required to be installed.

2.5.5 Marking Layout from Left Edge of Pavement

2.5.6 **Yield Lines (sharks teeth)** shall be installed at all locations where a Yield sign is used.

2.5.7 **"Only" Word Marking –** The pavement marking word symbol "ONLY" shall only be used on through lanes that terminate and requires users to turn left or right.

2.5.8 **Edge lines –** shall be placed as per section 3B.07 of the MUTCD.

3.0 Signs

{This chapter applies to signing on <u>all</u> RIDOT projects}

Guidance for this chapter was obtained from the following:
- RIDOT *Standard Specifications for Road and Bridge Construction*, latest edition
- *Manual on Uniform Traffic Control Devices,* latest edition

3.1 **School Warning signs** - all school warning signs in addition to the following signs should have a fluorescent yellow-green background with a black legend and border:

A. School Advance Warning sign (S1-1);
B. SCHOOL BUS STOP AHEAD sign (S3-1);
C. SCHOOL plaque (S4-3);
D. The "SCHOOL" portion of the School Speed Limit sign (S5-1);
E. XXX FEET plaque (W16-2 series);
F. AHEAD plaque (W16-9p);
G. Diagonal Arrow plaque (W16-7p); and
H. Reduced Speed School Zone Ahead sign (S4-5, S4-5a).

When the fluorescent yellow-green background color is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a zone or area should be avoided [Ref 2].

3.2 **Shared Use (Bicycle) Path Restriction Sign** – in a departure from the MUTCD a special "Walk on Left Facing Bikes" should be used in place of the R9-7 sign. It should be placed within100 feet of a bike path entrance and periodically along the path on long segments.

3.3 **Street Name Signs** – Overhead mounted street name signs shall be called for at all signalized intersections. The lettering should be 12 inches high in capital letters. If upper and lower-case letters are called for they should be 12 and 9 inches high, respectively. All ground mounted street name signs shall be 8 inches in capital letters or 8 inch upper-case with 6 inch lower case.

3.4 **Speed Limit Signs** – should be spaced: 1) so as to be visible to a motorist traveling at the posted speed approximately every 2 minutes. In example on a 30 mph roadway the speed limit sign spacing should be 1 mile. 2) After a major junction. 3) At locations having a change in speed limit.

3.5 **Left Turn Yield on Green** (R10-12) sign should be used to remind drivers of the right-of-way rule for left turns at signalized intersections [Ref. 10]. This sign is primarily intended for intersections where left turn movements are permissive from a left turn bay. The preferred location for this sign is overhead, where it is most likely to be seen and read.

3.6 **Sign Placement** – Directional, Regulatory, Warning signs should be placed per Figures 2A-1 and 2A-2 in section 2A-16 of the MUTCD

3.6.1 Lateral offsets - Although Figure 2A-1 shows 2 feet as the minimum lateral offset for the edge of a sign on a curbed sidewalk please note that section 2A.19 of the MUTCD **allows a lateral offset of 1 foot in urban areas where sidewalk width is limited or where existing poles are close to curbs**. Note: An ADA spot clearance of 32" must be maintained on a sidewalk.

4.0 Work Zone Traffic Control

{This chapter applies to work zones for <u>all</u> RIDOT projects}

Guidance for this chapter was obtained from the following:
- *NCHRP Report 475*, *A Procedure for Planning and Assessing Night Time Work Operations*
- RIDOT *Standard Specifications for Road and Bridge Construction*, latest edition
- *Manual on Uniform Traffic Control Devices,* latest edition

4.1 Shall be in conformance with the latest MUTCD.

4.2 **Work Restrictions**

Note: The procedure for determining work zone restrictions on <u>all</u> RIDOT projects is as follows:

<u>Default Work Zone Restrictions</u> shall be as shown in Table 4-1 (Default Work Zone Restrictions) of this section.

<u>Relief from the default work zone restrictions</u> - Lane and shoulder closures shall be allowed during the above referenced restricted times only under the following conditions:

A) The traffic volumes during the restriction falls below the thresholds of Table 4-2 (Work Zone Lane Capacities) for the 85th percent cases capacity; **<u>or</u>**
B) It can be demonstrated by a delay analysis that unacceptable congestion or delays will not occur (less than 15-minute delays). This can be determined by using the methods described in DPM 10-36 <u>or</u> by the use of software programs such as "QuickZone"; **<u>or</u>**
C) **By permission of the Chief Engineer**.

Table 4-1 Default Work Zone Restrictions

4.2.1	Freeways – in general:
	A. No lane closures will be allowed between the hours of 6:00 AM and 9:00 PM on any day of the week.
	B. No Shoulder Closures will be allowed between 6:00 AM and 9:00 AM or between 3:00 PM and 6:00 PM, Monday through Friday.
	C. No work of any kind will be allowed on Friday and Saturday night, between 7:00 PM and 6:00 AM the next morning.
4.2.2	Arterial Roadways:
	A. No lane Closures will be allowed between 6:00 AM and 9:00 AM or between 3:00 PM and 6:00 PM, Monday through Friday.
	B. No work will of any kind will be allowed on Friday and Saturday nights, between 7:00 PM and 6:00 AM the next morning.
4.2.3	Local Roadways:

A. Restrictions will be determined on a case-by-case basis.

4.2.4 Holidays:

A. **Memorial Day, Victory Day, Labor Day & Columbus Day**– No Saturday, Sunday, or Monday day or night work.

B. **Thanksgiving Day** - a. – No Wednesday night or Thursday day or night work – b. – No work that impacts traffic shall be performed by the contractor on Wednesday through Sunday of Thanksgiving week in any calendar year. Impacting traffic is defined as construction operations that reduce the number of travel lanes.

C. **Independence Day, Veterans Day, Christmas Day** no day or night work and no work previous night.

D. **Easter Sunday**– No Saturday night or Sunday day or night work

E. All Friday daytime work on any holiday weekend listed above must end by 1 PM.

Note: Neither time restrictions nor delay analysis are required if the traffic volumes during the work times do not exceed the average capacity as shown in the table below.

Table 4-2 Work Zone Lane Capacities

Number of Lanes		Average Capacity (vphph)	Capacity provided in 85 percent of cases
Normal	Open during construction		
3	1	1170	1020
2	1	1340	1270
5	2	1370	1340
4	2	1480	1440
3	2	1490	1450
4	3	1520	1490

Ref.: NCHRP Report 475

4.3 **Channelizing Devices**

4.3.1 Barrels should be used when a traffic control set-up is to remain beyond working hours when no workers are present.

4.3.2 Cones should be used when traffic control set-up is utilized only during workings hours and it is subsequently broken down at the end of the workday.

4.3.3 Tubular Markers – See section 6F.60 of the MUTCD for appropriate use.

4.3.4 Type III Barricades - See section 6F.63 of the MUTCD for appropriate use.

4.4 **Traffic Control Persons/Flaggers:**

4.4.1 **Traffic Persons (Police Officers)** should be called for in place of flaggers when work will impact:

A. Busy Intersections including all signalized intersections.

B. Limited Access Roadways.

C. Under Unusual Circumstances.

Please Note: Flagger Ahead Signs should be utilized if the police officers are stationed outside their vehicle and not protected by barrier.

4.4.2 **Flaggers**:

A. Should be utilized and stationed per the typical applications in Part VI of the MUTCD.
B. Should not be utilized to control traffic on limited access highways or busy intersections.

4.5 **Travel Lane Minimum Widths** through work zone.

4.5.1 Opposing Travel Lanes should be 11-foot minimum.

4.5.2 Travel Lanes in the same direction may be a minimum of 10 feet but preferably should be 11 feet.

4.6 **Shoulder Use –** when lane closures are called for the use of paved shoulders, as travel lanes, should be considered as long as they meet the criteria in section 4.5.

5.0 Traffic Signal Projects

{This chapter applies to all RIDOT traffic signal projects}

Guidance for this chapter was obtained from the following:

- *NCHRP Report 3-54*, *Evaluation of Traffic Signal Displays for protected permitted left-turn Control*
- *NCHRP Report 475*, *A Procedure for Planning and Assessing Night Time Work Operations*
- RIDOT *Standard Specifications for Road and Bridge Construction*, latest edition
- *Manual on Uniform Traffic Control Devices,* latest edition
- *ITE Traffic Engineering Handbook*, latest edition
- *Traffic Control Devices Handbook*, latest edition

5.1 **General Notes – Traffic Signal** should be located in the General Notes plan sheet and should include all applicable notes listed in Appendix A.

5.2 **Traffic Signal Plans** – Traffic Signal Plans should display the following:

- Phasing and Timing Diagram
- Phase Sequence (Ring Structure)
- Loop Detector Chart (see TAC latest edition)
- Traffic Signal Legend
- Conduit and Wiring Diagram
- Traffic Signal Faces (Proposed and Existing-to-Remain)
- Existing and proposed traffic signal equipment
- Pole location diagram (mast Arm, span, and pedestrian head poles)
- Signing and Striping
- List of equipment to be removed and disposed and/or salvaged.
- Traffic Signal Number (to be assigned by RIDOT Traffic)

Note: The base mapping for a Traffic Signal Plan should be in gray scale and should include existing layout and features such as edge of pavement or curb line, sidewalks, wheelchair ramps, street names, signing, striping, utilities, ROW, traffic signal equipment, and any other pertinent features. All proposed modifications should be dark line.

5.2.1 **Phasing and Timing Diagram** (see appendix B for example)

A. The yellow change interval and red clearance interval should be set according to the ITE formulas for calculating change and clearance intervals.

Table 5-1 Recommended Yellow Change and Red Intervals for Level Grades

85th Percentile Speed		Yellow Change and Red Clearance Intervals, in Seconds, for Width of Intersection, in feet (Partial Intersection Clearance)								
		40'	60'	80'	100'	120'	140'	160'	180'	200'
20 MPH	Y	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	R	1.0	1.5	2.0	3.0	3.5	4.5	5.0	5.5	6.5
25 MPH	Y	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	R	1.0	1.0	1.5	2.0	2.5	3.0	4.0	4.5	5.0
30 MPH	Y	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
	R	1.0	1.0	1.0	1.5	2.0	2.5	3.0	3.5	4.0
35 MPH	Y	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
	R	1.0	1.0	1.0	1.0	1.5	2.0	2.5	3.0	3.0
40 MPH	Y	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	R	1.0	1.0	1.0	1.0	1.5	1.5	2.0	2.5	2.5
45 MPH	Y	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	R	1.0	1.0	1.0	1.0	1.0	1.5	1.5	2.0	2.5
50 MPH	Y	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	R	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5	2.0
55 MPH	Y	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	R	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5
60 MPH	Y	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	R	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5
65 MPH	Y	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
	R	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5

Based on formulas from ITE Traffic Control Devices Handbook 2001 Ed. (Ref. 5)

B. Phase Memory should be set to "Non-Lock" when presence loop detectors are called for.
C. Vehicle Extension (passage/gap) times should be set according to Table 5-2 below.

Table 5-2 Vehicle Extensions Times

85th percentile speed		**Time over 40' Loop**	**Extension Time (assuming 3.5 sec headway)**
MPH	**FPS**		
20	29.3	1.37 sec	2.1
25	36.7	1.09 sec	2.4
30	44.0	.91 sec	2.6
35	51.3	.78 sec	2.7
40	58.7	.68 sec	2.8
45	66.0	.61 sec	2.9
50	73.3	.55 sec	3.0
55	80.7	.50 sec	3.0

D. Phase Recalls should be set "Minimum-On" for the mainline through phase.
E. Pedestrian times – the initial walk time interval should be set to a minimum of 4 seconds. Also, the pedestrian clearance time should be set using a maximum pedestrian walk speed of 4.0 feet per second. If the signal is to be heavily utilized

by elderly persons or children a lower more appropriate walk speed should be considered.

F. Left turn phasing should generally be as recommended in Chapter 13 of the ITE Traffic Engineering Handbook [ref. 4]. However, due to the left-turn yellow trap safety problem [Ref. 9] we do not typically propose "Lead-Lag" phasing. Also, we do not allow "Protected/Permissive" left-turn movements from an exclusive left-turn bay when left turns must cross two or more lanes or on roadways with vehicle speeds 40 mph or greater. "Permissive only" phasing at a left-turn bay should not generally be called for but may be utilized when analyzed on a case-by-case basis.

Note: The left-turn phasing of adjacent traffic signals along an arterial must be considered when selecting the appropriate left turn phase for a specific intersection. This is for the purpose of consistency and driver expectation.

G. Right Turn Overlaps (right arrow indication) should be considered during cross street exclusive left turn movements when: 1) a right turn bay exists and 2) right turn volumes are high or cross street left turn volumes are high.

5.2.2 **Phase Sequence** (Ring Structure) – should be single ring unless combination of movements require dual ring phasing.

5.2.3 **Loop Detector Chart** (see TAC, latest edition) in Appendix B.

A. The loop delay times should be set according to the Table 5-3 below:

Table 5-3 Loop Delay Chart

Loop Location	Delay (Seconds)
Main Line Through Lanes	3
Left Turn Bay	3
Side Street	3 to 5
Side Street Right Turn Movements	5 to 8

5.2.4 **Traffic Signal Legend** should include callouts, item codes, symbols and description. Legend numbers and descriptions should be consistent with the example in Appendix D.

5.2.5 **Conduit and Wiring diagram**

A. **Traffic Signal Wire Conduit** should be 3-inch PVC Schedule 40. All signal wire conduit crossing a roadway should be 3-inch PVC Schedule 80.

B. **Loop Detector Conduit** should be 2-inch PVC Schedule 40. All loop wire conduit crossing a roadway should be 2-inch PVC Schedule 80. **Note:** When loop wire is sharing conduit with signal wire the conduit should be as called for in paragraph A above.

C. **Traffic Power Cable Conduit** should be 2 inch RSC from the controller cabinet meter socket the entire distance underground to the utility pole and up it for a length of 10 feet. The remaining segment of conduit up the utility pole should be 2" PVC.

D. **Communication Cable Conduit** should be 2 inch RSC from the controller cabinet foundation the entire distance underground to the utility pole and up it for a length of 10 feet. The remaining segment of conduit up the utility pole should be 2" PVC.

E. **Traffic Signal Inter-connect Conduit** should be 3 inch PVC for twisted copper pairs. When a fiber-optic inter-connect is called for, a dual 1¼" inch High Density

Poly Ethylene (HDPE) conduit should be used for the back bone and a single 1¼" HDPE conduit for the tap cables.

F. **Traffic Signal Wire** – there should be one conductor per output plus a ground wire and a spare wire. For example a three section vehicle signal head would utilize one conductor for each of the 3 section indications (red, yellow and green) plus one conductor for the ground and another conductor as a spare for a total of 5 conductors. Therefore, a 5-conductor cable will be called for a three section head. See Table 5-4 below for wire and cable requirements.

Table 5-4 Wire and Cable Requirements

Signal Equipment	Cable
1 Way 3 Section Signal Head	5 Conductor #14 AWG
1 Way 4 Section Signal Head	7 Conductor #14 AWG
1 Way 5 Section Signal Head	7 Conductor #14 AWG
1 Way Pedestrian Signal Head	5 Conductor #14 AWG
2 Way Pedestrian Signal Head	7 Conductor #14 AWG
Pedestrian Push Button	3 Conductor #14 AWG
2 Way 3 Section Signal Head	9 Conductor #14 AWG
3 Way 3 Section Signal Head	12 Conductor #14 AWG
Loop Lead-in	2 Conductor Shielded #14 AWG
Opticom	3 Conductor Shielded #20 AWG

Table 5-5 Guidelines for Traffic Signal Wire and Cable Quantity Take-Offs

Equipment	Rule of Thumb	Derivation/Logic/Comments
Mast Arms	Include 30' for quantity up/down mast arm	20' mast arm + 5' bends on top and bottom
Span Poles	Include 35' for quantity up/down span poles	25' span pole + 5' bends on top and bottom
Span Wires	Include 10% sag for cable	Applied to tether wire as well
Traffic and Pedestrian Signal Head Cable	Include 5' extra at the signal head Include 15' for quantity down post or pole mounted Include 20' for quantity up span pole	**Do not include** extra when going "through" another signal head. 10' mounting height + 5' bend on bottom 25' span pole - 10' mounting height + 5' bend on top.
Pedestrian Push Button Cable	Include 10' for quantity down post or pole mounted Include 25' for quantity up span pole	Say 5' mounting height + 5' bend on bottom 25' span pole - 5' mounting height + 5' bend on top.
Loop Detectors	Quantity based on size of entire saw cut	Includes loop and wire to hand hole
Hand Holes	Include 10'extra for each wire in hand hole unless otherwise specified (fiber optics, etc.)	For bends and 5 feet of slack per R.I. Std. Specifications
Cabinets	Include 10' extra for each wire in cabinet	To provide sufficient slack for wiring

G. **Interconnect Cable** should be a 6 Pair #19 AWG twisted shielded communication cable or 12-strand single mode fiber optic cable. The use of either twister copper pairs or fiber optic cable is dependent on system needs in terms of bandwidth.

Please Note: When estimating the wiring and cable quantities keep in mind that the Rhode Island Specifications call for 5 feet of slacked wire in hand holes.

5.2.6 **Traffic Signal Faces** - Proposed and Existing-to-Remain should be shown as a separate detail on plan. They should be shown with back plates. All signal heads should contain L.E.D. Modules and not incandescent bulbs or fiber optic material. Also, a 4th section dual arrow indication should be used as opposed to a five-section "dog house" configuration. Further, unless absolutely necessary, we prefer that all signal heads be overhead mounted as opposed to pedestal mounted.

5.2.7 **Pedestrian Signal Heads and Buttons** - Proposed and Existing-to-Remain should be shown on plan. The pedestrian signal faces should be shown on plan and should be the L.E.D. filled-in (as opposed to outline) hand/man symbols. Pedestrian Heads and Buttons should be called for at all locations where sidewalks exist. The count down type pedestrian signal heads and "Bull Dog" type push button detectors should be called for at high pedestrian volume locations such as tourist locations, central business districts, and upon request at specialized locations such as near elderly housing.

5.2.8 **Traffic signal equipment layouts**, existing and proposed, should be displayed to ensure there is no conflict with existing equipment while constructing the new system.

5.2.9 **Pole location diagrams or blow-ups** showing mast arm, span pole, and pedestrian head poles locations should be included on the plan sheet. The pole locations should be dimensioned to fixed objects and fixed by station and offset to ensure proper placement during construction. Also, the poles should be dimensioned from front of sidewalk to ensure compliance with ADA clearance regulations.

5.2.10 **Signing and Striping** should be included on the traffic signal plan at signalized intersections. Signing and striping should be shown on separate signing and striping plan sheets for roadway segments between signalized intersections. A graphic of the sign face should be shown next to all sign designation call outs.

5.2.11 **List of equipment** to be removed and disposed and/or salvaged should be included on plan.

5.2.12 **Signal Head Spacing Table or Diagram** should be included on plan and should show distances from center of mast arm to each signal head.

5.2.13 **Traffic Signal Number** (to be assigned by the RIDOT Traffic Design Section) should be included above title block on plan sheet.

5.2.14 **Miscellaneous** – all of the above items should be included on a single plan sheet for each intersection. If the signal plan becomes too cluttered, any and all of the following can be displayed separately somewhere else on the sheet: 1) wiring diagram, 2) pole location diagram and 3) signing and striping.

5.3 **Traffic Signal Interconnect Plan/System Architecture Plan** – should be in the 40 to 100 scale range and should show the following:

5.3.1 Legend

5.3.2 Intersection street names

5.3.3 Conduit and communication layout with associated size and type call outs
5.3.4 Handhole and/or manhole locations
5.3.5 Test pit/vacuum probe locations
5.3.6 Controller Cabinet and master locations.
5.3.7 System detectors
5.3.8 ITS equipment location
5.3.9 ITS system architecture
5.3.10 Necessary notes

5.4 **Constructability Issues** – The following issues should be considered.

5.4.1 **Temporary Traffic Signals** may be required when it is not possible to construct a new traffic signal system while existing system is operating.

5.4.2 **Re-use of existing conduit –** Generally, all new conduit and hand holes should be called for in a new traffic signal system. However, when existing conduit is to be retained for use in a new signal installation (usually in order to minimize trenching across pavements) a sequence of construction should address how the intersection is to remain signalized during construction.

5.4.3 **Automatic Trenching Machine** (a.k.a Vermeer Wheel) should be called for in accordance with R.I Std. 18.6.0 when conduit is being place across roadway surfaces that will not be replaced during the project. The intent of this is to minimize damage to the riding surface. Similarly, in an effort to minimize the disturbances to both the riding surface and to the motoring public, horizontal drilling should be considered when trenching across freeway sections.

5.4.4 **Vacuum Probes** should be called for at all proposed span pole, mast arm, and pedestrian signal head pole locations. This is to ensure that foundations can be placed at proposed locations without conflicting with utilities or bedrock. Like wise, if there is a potential conflict point between existing utilities and conduit, hand-hole, manhole, or cabinet foundations then vacuum probes should be called for. This non-intrusive method allows for safely locating utilities without damaging them or disturbing the in-situ soil. Please note: The proposed vacuum probes should specify a specific hole depth and width corresponding to the appropriate foundation or handhole dimensions or potential conduit conflict area. All vacuum probe locations should be dimensioned to nearby fixed objects on plans as opposed to being fixed to a baseline station and offset. This allows the utility locator to quickly and accurately identify probe location without the need of a survey crew and associated required traffic control.

5.4.5 **Americans with Disabilty Act** (ADA) considerations – ADA law requires that there be a 32" minimum clearance width (with a goal of 36") at spot restrictions less than 24" in length along a sidewalk. As such all traffic signal equipment including poles and cabinets should ideally be placed in back of sidewalk. This may require minor land taking in some situations. If it is not possible or feasible to place the equipment behind sidewalk, all poles and cabinets should be dimensioned from the front of sidewalk to ensure that minimum clearances are met.

5.4.6 **Mast Arms vs. Span Poles** – mast arms are generally preferred over span poles in supporting overhead traffic signal heads [ref. DPM 10-18]. Mast arms allow for rigid mounts, uniform-mounting heights and are esthetically pleasing. Where it is impractical to use mast arms, such as at wide rural or suburban intersections where the required mast arm lengths would exceed 40

feet, span poles should be utilized. Mast arms ideally should be placed at the far side of every approach at a 90 degree angle (perpendicular to traffic).

5.4.7 **Traffic Signal Heads –** all mast arm mounted signal heads are to be "one-way." Our standards call for traffic signal heads to be rigidly mounted to mast arms. It is difficult to bracket mount two or three way heads to a mast arm.

5.4.8 **Vehicle Loop Detectors –** should only be placed in pavements that are in good condition. Pavements that are not in good condition should be cold planed and overlaid prior to a loop installation.

5.4.9 **Traffic Signal Controller Cabinets -** should be located behind sidewalk if possible.

REFERENCES:

1. ***Manual of Transportation Engineering Studies*, ITE (2000 Ed.) publication No. TB-012, Washington, DC.**
2. ***Manual on Uniform Traffic Control Devices*, FHWA (2003 Ed.) Washington, DC.**
3. **Rhode Island Department of Transportation *Standard Specifications for Road and Bridge Construction*, 2004 Ed. RIDOT**
4. ***Traffic Engineering Handbook*, 5th Edition ITE (1999)**
5. ***Traffic Control Devices Handbook*, (2001 Ed.) ITE publication No. IR-112, Washington, DC.**
6. ***NCHRP Report 475*, *A Procedure for Planning and Assessing Night Time Work Operations*, TRB/NRC, Washington D.C. 2002**
7. ***NCHRP Report 518, Safety Evaluation of Permanent Raised Pavement Markers*, TRB/NRC, Washington D.C. 2004**
8. ***Trip Generation Handbook*, 6th Ed., ITE (200x)**
9. ***NCHRP Report 3-54*, *Evaluation of Traffic Signal Displays for protected permitted left-turn Control,* TRB/NRC, Washington D.C. 2002**
10. ***A pocket Guide to Improve Traffic Control and Mobility for our Older Population, USDOT/FHWA (2003), Washington, D.C. 20590***

Appendix A: General Notes - Traffic Signal

(These Notes Must Be Included In All Projects That Contain Traffic Signal Work)

1. ALL SALVAGED TRAFFIC SIGNAL EQUIPMENT SHALL BE DELIVERED TO THE RIDOT ANTHONY FACILITY, 16 MAPLEDALE STREET, COVENTRY, RHODE ISLAND, 02816.
2. BACK PLATES ARE REQUIRED ON ALL TRAFFIC SIGNAL HEADS AND SHALL BE INCLUDED IN THE PRICE OF THE SIGNAL HEAD.
3. THE CONTRACTOR SHALL SUPPLY AND INSTALL ON THE UPPER LEFT HAND CORNER OF THE BACK OR THE CONTROLLER CABINET DOOR A LAMINATED INTERSECTION GRAPHIC AND TABLE DEPICTING THE TRAFFIC DETECTOR RELAY CHANNEL ASSIGNMENTS. THE DIAGRAM SHALL BE A GRAPHIC OF THE INDIVIDUAL INTERSECTION ORIENTED SIMILAR TO THE PLANS SHOWING THE LOCATIONS OF EACH OF THE LOOP DETECTORS. THE DIAGRAM SHALL, AT A MINIMUM, INCLUDE DETECTOR NUMBERS, STREET NAME LABELS, NORTH ARROW, AND CONTROLLER CABINET LOCATION. THE ASSIGNMENT INFORMATION SHALL BE INCLUDED IN A TABLE WHICH SHALL INCLUDE, AT A MINIMUM, THE APPROACH NAME, DETECTOR NUMBER, TERMINAL NUMBER, DETECTOR RACK SLOT NUMBER, RELAY NUMBER, RELAY CHANNEL NUMBER, AND PHASE ASSOCIATED WITH EACH DETECTOR.
4. TRAFFIC CONTROLLER SHALL BE ORIENTED SO THAT THE CABINET DOOR IS FACING SIDEWALK, UNLESS OTHERWISE STATED ON PLANS.
5. TRAFFIC CONTROLLER CABINETS, UNLESS OTHERWISE NOTED, SHALL BE NEMA TS2 TYPE 1 CABINET SIZE 6 (“P” TYPE) WITH NOMINAL DIMENSIONS OF 52”Hx44”WX24”D.
6. ALL DELAY AND EXTENSION TIMES, AS CALLED FOR ON THE PLANS, FOR PROPOSED LOOP DETECTORS SHALL BE PROGRAMMED IN THE TRAFFIC SIGNAL CONTROLLER AND NOT THE DETECTOR RELAY.
7. A BARE GROUND WIRE SHALL BE PLACED IN ALL PVC CONDUITS AND SHALL BE BONDED TO GROUND RODS IN ACCORDANCE WITH SECTION T.03 OF THE RHODE ISLAND DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD AND BRDIGE CONSTRUCTION. “BARE GROUND WIRE” WILL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE PRICE OF PVC CONDUIT ITEMS.
8. FINAL PLACEMENT OF SIGNAL HEADS, DETECTORS, STOP BARS AND CROSSWALKS TO BE DETERMINED IN THE FIELD DURING CONSTRUCTION ACCORDING TO OBSERVED INTERSECTION CHARACTERISTICS BY THE ENGINEER.
9. A 2-FOOT MINIMUM BUFFER SHALL BE PROVIDED BETWEEN THE CURB AND ALL LATERAL OBSTRUCTIONS (INCLUDING ALL SIGNAL POLES AND TRAFFIC/PEDESTRIAN SIGNAL HEADS) TO PROVIDE ADEQUATE CLEARANCE FOR TURNING VEHICLES.
10. ALL FOUNDATIONS MUST HAVE CONES OR BARRELS BOLTED TO FOUNDATION BASES UNTIL ACTUAL POLE IS INSTALLED.
11. WHEN PLACING TRAFFIC SIGNAL HANDHOLES OR CONDUIT IN EXISTING PORTLAND CEMENT CONCRETE SIDEWALKS, THE ENTIRE SIDEWALK SQUARE OF CONCRETE SHALL BE REPLACED IN ACCORDANCE WITH R.I. STANDARD 43.1.0. NO PATCHES WILL BE ALLOWED.
12. ACCESS TO PEDESTRIAN PUSHBUTTONS SHALL MEET ADA REQUIREMENTS. ALL PEDESTRIAN PUSHBUTTONS SHALL BE ADA COMPLIANT WITH A 2” DIAMETER. SIGNS INSTALLED AT PROPOSED PEDESTRIAN PUSHBUTTONS SHALL BE MUTCD 2003 CODE R10-3B (LEFT OR RIGHT) AND SHALL BE INSTALLED SO THAT IT IS CLEARLY INDICATED WHICH CROSSING IS ASSIGNED TO EACH BUTTON.
13. ALL LOOP DETECTORS SHALL BE CENTERED WITHIN EACH LANE AS DELINEATED, UNLESS OTHERWISE DIMESIONED ON PLANS.
14. ALL LOOP DETECTORS SHALL BE CUT INTO THE FINAL PAVEMENT SURFACE COURSE.
15. TRAFFIC SIGNAL CONTROLLERS SHALL BE WIRED SO THAT ANY FIRE PRE-EMPTION SHALL OVERRIDE MANUAL (PUSH BUTTON) OPERATION.

16. THE CONTRACTOR SHALL WORK CONTINOUSLY TO RESTORE TRAFFIC SIGNAL OPERATION TO ITS INTENDED PURPOSE WHEN REPLACING THE TRAFFIC SIGNAL EQUIPMENT. A POLICE DETAIL IS REQUIRED TO DIRECT TRAFFIC AT THE INTERSECTION AT ALL TIMES DURING THE TRAFFIC SIGNAL IS INOPERATIVE. AT NO TIME SHALL THE CONTRACTOR LEAVE THE SITE BEFORE RESTORING FULL TRAFFIC OPERATIONS.

Appendix B:

Relevant DPMS and to All Consultant Letters

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Rhode Island Department of Transportation
ENGINEERING DIVISION
Two Capitol Hill, Rm. 226
Providence, RI 02903-1124
PHONE 401-222-2023
FAX 401-222-3435; TDD 401-222-4971

March 20, 2000

To: All Consultants

Subject: Loop Detector Numbering Scheme for TS-2 Controllers

The current specification for TS-2 Controllers and Cabinets calls for an eight slot detector rack which provides for sixteen channels of detection. Under NEMA TS-2 there is no hard wire connection from the detector amplifier rack to the controller phase inputs. A NEMA TS-2 controller always interprets the inputs from the rack in the following manner:

Slot	1	2	3	4	5	6	7	8
Loop Detector No.	3,4	1,2	7,8	5,6	11,12	9,10	15,16	13,14

To simplify the process of building, programming and troubleshooting controller cabinets, the following guidelines should be followed to ensure the loop detector numbers match the default numbers used in the NEMA specifications. We note this procedure may produce gaps in the loop numbering sequence:

1. Adjacent loop detectors must always be on the same relay.

2.Two-channel relays can be used in any slot. The loop detector number is assigned on the basis of the slot used. For example, any loops connected to a two-channel relay in slot 1 must be numbered as loop detectors 3 & 4. Loops connected to a two-channel relay in slot 4 are numbered as loop detectors 5 and 6.

3. Four-channel relays can only be used in even numbered slots. They utilize the outputs assigned to the even numbered slot and the adjacent lower odd-numbered slot. Loop detectors assigned to a four-channel relay in slot 2 can be numbered 1, 2, 3, and 4. A four-channel relay in slot 4 controls loop detectors 5, 6, 7 and 8.The loop detector number is assigned on the basis of which slot is used.

Slot	2	4	6	8
Loop Detector No.	1,2,3,4	5,6,7,8	9,10,11,12	13,14,15,16

4. Both two and four channel amplifiers can be used in a detector rack. The loop detector number is assigned on the basis of which slot is used by the relay.

Attached is an example intersection layout and detector table. The easiest way to manage loop detector numbering is to include a Slot Number column in the detector table. The following discussion is related to the attached example.

The WB approach has three loops. Adjacent loops must be on the same relay to avoid loop crosstalk and false actuations, so these loops must be on a four-channel relay. We have chosen to place this relay in slot 2, and have numbered the loops 1, 2, and 3.

The EB approach has two loops. Because adjacent loops must be on the same relay we have assigned them to a four-channel relay in slot 4 and numbered them as loops 5 and 6.

The N&S loops do not have any adjacent loops. They do not need to be on the same relay. We have a single unused channel on the relay in slot 2 (detector 4) and two unused channels on the relay in slot 4 (detectors 7 & 8). We have chosen to utilize the relay in slot 4, so the loop detectors are assigned the numbers 7 and 8. The detector table lists loops 1, 2, 3, 5, 6, 7 and 8. There is no loop 4 because one channel on the four-channel relay in slot 2 was not used.

Every intersection is different, so many different loop numbering schemes are possible. The above described methodology will help ensure the loop numbering scheme reflects the way controller cabinets are built and the way TS-2 controllers utilize detector rack inputs. Should you have any questions, or require any assistance please contact Traffic Engineering at (401) 222-2694.

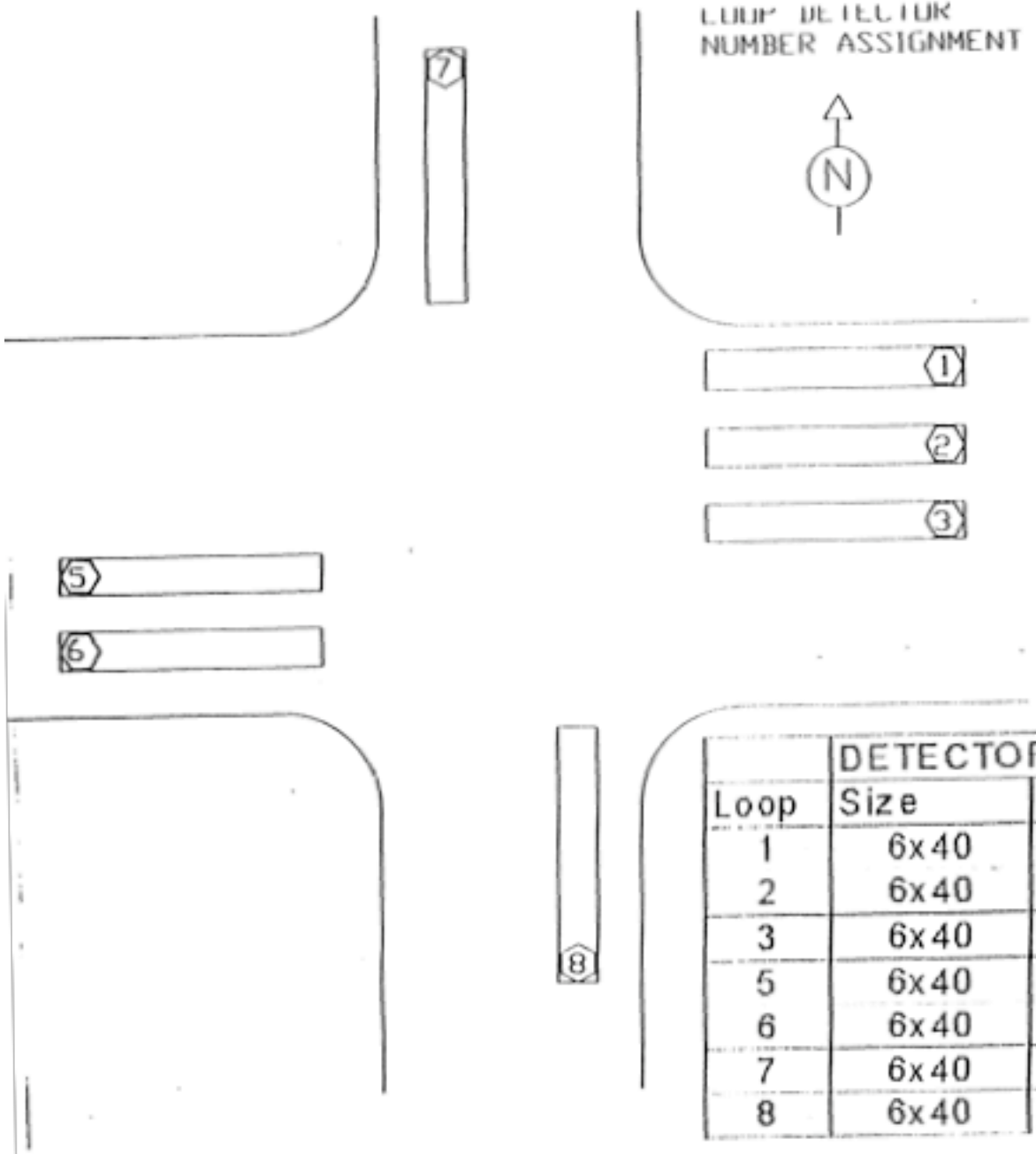
Very truly yours,

Edmund T. Parker, Jr., PE
Chief Design Engineer
Transportation

nm/wp

cc: Messrs. Capaldi, Parker, Bennett, Annarummo, Farhoumand, All Project Engineers; File

LOOP DETECTOR
NUMBER ASSIGNMENT



	DETECTOR		TABLE		
Loop	Size	Relay	Slot	Phase	Delay
1	6x40	1	2	2	3
2	6x40	1	2	2	3
3	6x40	1	2	1	3
5	6x40	2	4	2	3
6	6x40	2	4	2	3
7	6x40	2	4	3	8
8	6x40	2	4	3	8

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Rhode Island Department of Transportation
ENGINEERING DIVISION
Two Capitol Hill, Rm. 226
Providence, RI 02903-1124
PHONE 401-222-2023
FAX 401-222-3435; TDD 401-222-4971

May 4, 2001

To All Consultants:

Subject: Traffic Signal Phase Sequence

Design consultants should be aware the vehicle movement numbering convention (odd numbered lefts, even numbered thrus) used for analyzing signalized intersections only matches the NEMA phase numbering scheme for a dual ring, quad left operation. It is not compatible with single ring or other dual-ring and multiple ring operations.

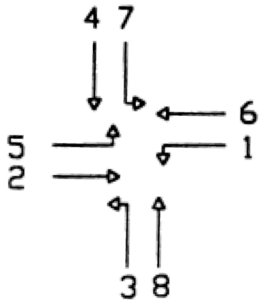
When evaluating intersection phasing single-ring, sequential is the preferred configuration. Dual-ring or multi-ring operation should only be used if it is necessary to provide a special phase sequence or it will provide a more efficient operation. The phase sequence of each ring shall be shown in the Phase Sequence Diagram. If the phase sequence changes on a time-of-day basis, the ring structure and phase sequence for each time period must also be shown on the project plans.

Please distribute as necessary. Sample Phase Sequence Diagrams are shown on the attached sheet. Should you have any questions, please contact Theodore Coleman in the Department's Traffic Engineering Unit at 222-2694 x4203.

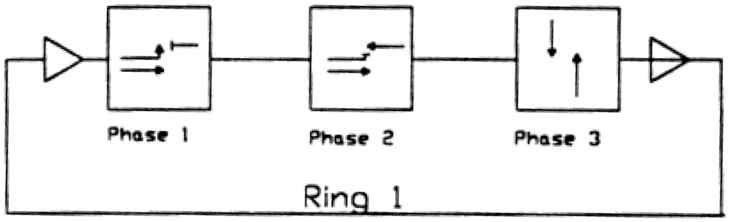
Sincerely,

Edmund T. Parker, Jr., PE
Chief Design Engineer
Transportation

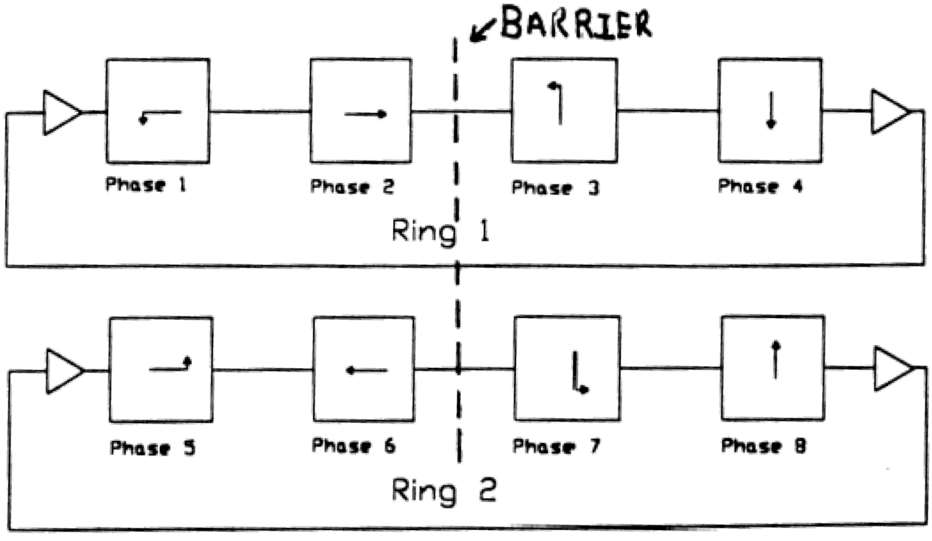
Movement Numbering Convention



PHASE SEQUENCE DIAGRAMS



Single Ring Operation



Dual-Ring Quad-Left

Appendix C (Part 1):

Example Forms, Charts and Tables

(Included in this appendix are example forms, charts and tables, used in previous RIDOT projects, that are in the preferred format. Please ensure that all proposed forms, tables, and charts are in substantial conformance with the examples.)

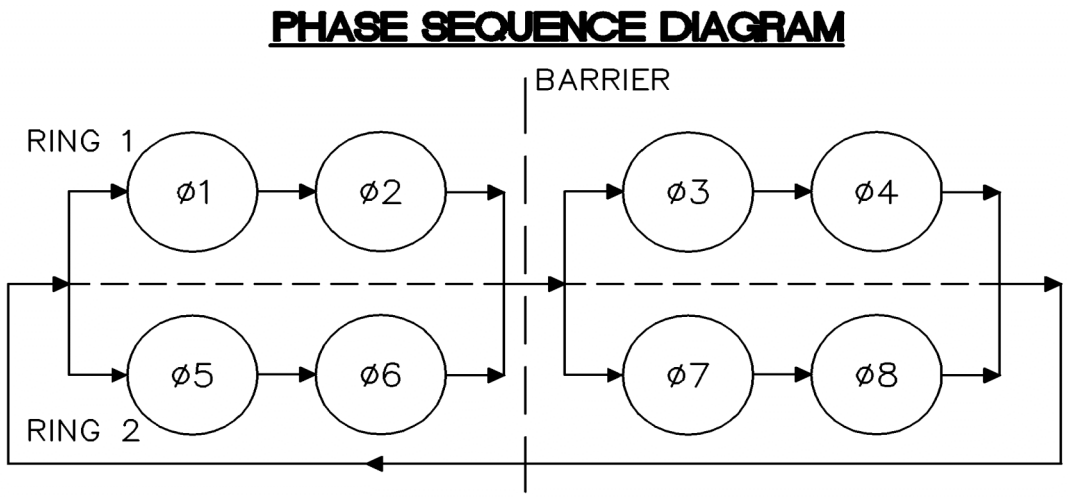
Example Loop Detector Data Table:

DETECTOR DATA						
DETECTOR NO.	NO. SECTION/ SIZE	RELAY NUMBER	SLOT	DELAY (SEC)	CALL PHASE	REMARKS
1	1–6'x40'	1	2	3	ø5	PROPOSED
2	1–6'x40'	1	2	3	ø2	PROPOSED
3	1–6'x40'	1	2	3	ø2	PROPOSED
5	1–6'x40'	2	4	3	ø1	PROPOSED
6	1–6'x40'	2	4	3	ø6	PROPOSED
7	1–6'x40'	2	4	3	ø6	PROPOSED
9	1–6'x40'	3	6	5	ø7	PROPOSED
10	1–6'x40'	3	6	5	ø4	PROPOSED
11	1–6'x40'	3	6	5	ø4	PROPOSED
13	1–6'x40'	4	8	5	ø3	PROPOSED
14	1–6'x40'	4	8	5	ø8	PROPOSED
15	1–6'x40'	4	8	5	ø8	PROPOSED
17	1–6'x6'	5	10	–	SYSTEM DETECTOR	PROPOSED
18	1–6'x6'	5	10	–	SYSTEM DETECTOR	PROPOSED
19	1–6'x6'	5	10	–	SYSTEM DETECTOR	PROPOSED
20	1–6'x6'	5	10	–	SYSTEM DETECTOR	PROPOSED

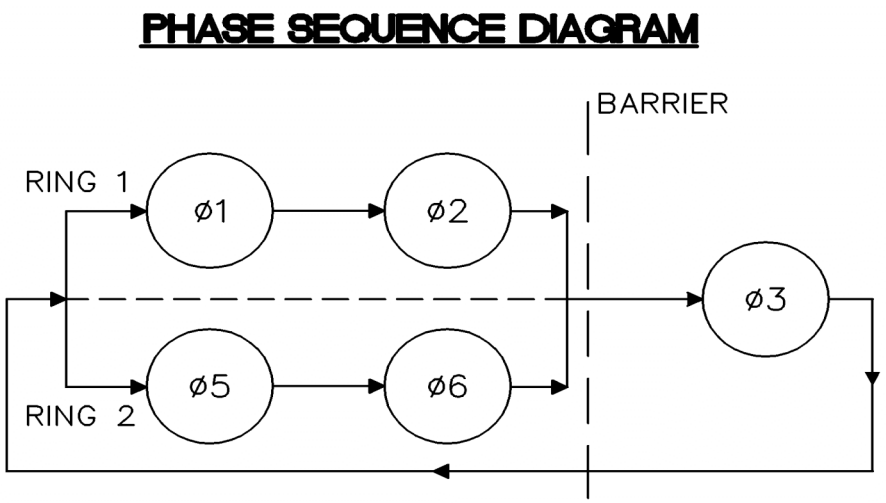
NOTES:

1. DETECTORS 2, 3, 6, AND 7 TO BE "CALL NON–ACTUATED" DURING COORDINATED OPERATION.
2. SYSTEM DETECTORS (DETECTOR NOS. 17–20) SHALL BE INITIALLY PROGRAMMED IN THE CONTROLLER TO RECORD VOLUME DATA.

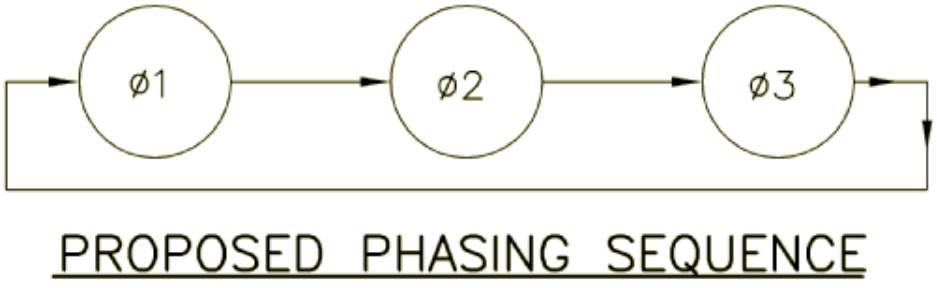
Example Dual Ring Phasing:



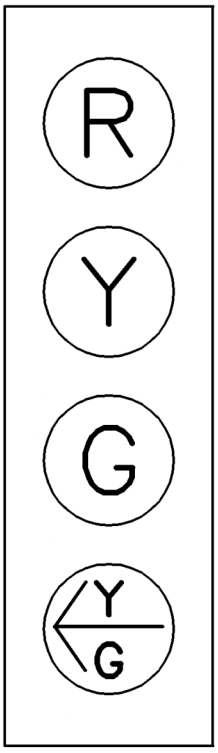
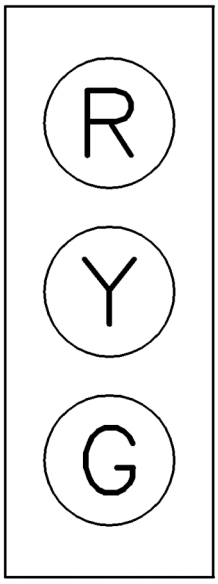
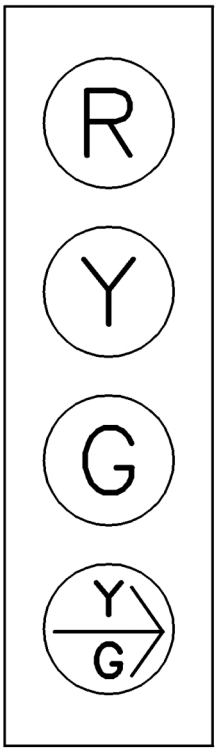
Example Dual **Ring/Single Ring Mix:**



Example Single Ring:



Example Signal Head Data Table:

SIGNAL HEAD DATA			
A,C	B,D,E,F,G	H	P1–P4
			 (ALL L.E.D. MODULES)
ALL 12" LENS			

NOTES:

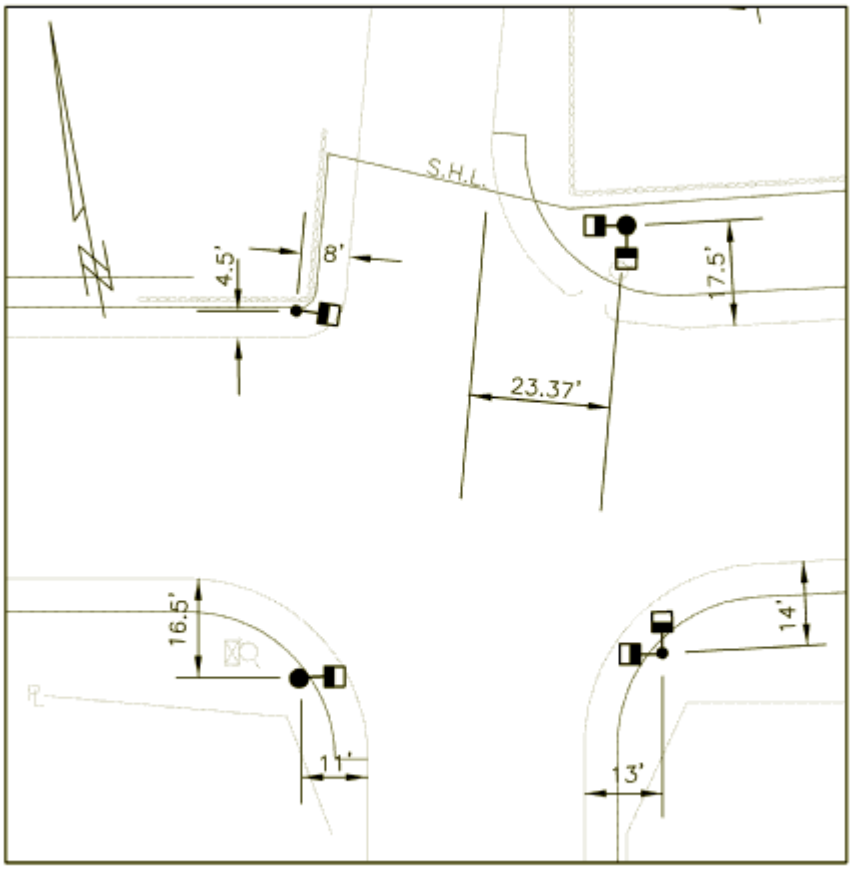
1) ALL TRAFFIC AND PEDESTRIAN SIGNAL HEADS ARE PROPOSED.
2) ALL RED, YELLOW, AND GREEN SIGNAL DISPLAYS SHALL BE EQUIPPED WITH LED MODULES.
3) ARROW DISPLAYS SHALL BE MADE UP OF TWO ROWS OF LED MODULES.

Example Remove and Salvage Table:

REMOVE AND SALVAGE TRAFFIC SIGNAL EQUIPMENT
TRAFFIC SIGNAL NO. 576*

1	CONTROLLER AND FOUNDATION
8	VEHICLE SIGNAL HEADS W/ ASSEMBLY
0	PEDESTRIAN SIGNAL HEADS W/ ASSEMBLY
1200'	WIRE AND CABLE
2	SPAN POLES

Example Pole Location Diagram:



POLE LOCATION DIAGRAM

Example Coordination Data Table:

COORDINATION DATA

(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC.	80 SEC.	
OFFSET	75	75	
PHASE ø1	16	16	
PHASE ø2	42	42	
PHASE ø3	22	22	
PHASE ø5	16	16	
PHASE ø6	42	42	
COORDINATED PHASE	ø2&ø6	ø2&ø6	

NOTES:

1. SEE PLAN SET 1 FOR TRAFFIC SIGNAL PLAN.
2. CLEARANCE TIME FOR ø3 PEDESTRIAN PHASE SHALL CONTINUE INTO ø3 YELLOW CLEARANCE INTERVAL

Appendix C (Part 2):

Example Forms, Charts and Tables

(Included in this appendix are example forms, charts and tables, used in previous RIDOT projects, that are in th preferred format. Please ensure that all proposed forms, tables, and charts are in substantial conformance with th examples.)

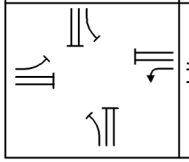
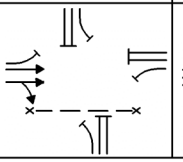
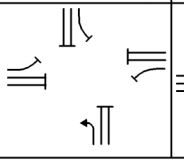
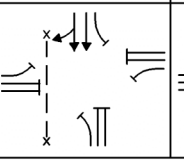
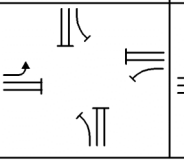
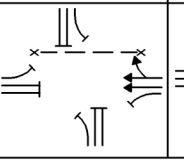
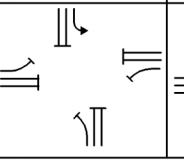
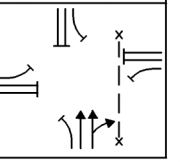
Example Sequence and Timing Diagram (Quad-Left Phasing):

SEQUENCE AND TIMING DIAGRAM

APPROACH	DIRECTION	HOUSING	ø1			ø2			ø3			ø4			ø5			ø6			ø7			ø8			FLASHING OPERATION
MINIMUM INTERVAL			5			11			5			8			5			11			5			8			
VEHICLE EXTENSION			2.2			2.8			2.2			2.8			2.2			2.8			2.2			2.8			
MAXIMUM 1			8			28			11			18			8			28			11			18			
MAXIMUM 2			8			28			11			18			8			28			11			18			
YELLOW CLEARANCE				3.5			3.5			3.5			3.5			3.5			3.5			3.5			3.5		
RED CLEARANCE					1.5			1.5			1.5			1.5			1.5			1.5			1.5			1.5	
PED. WALK/CLEARANCE						5/16						5/18						5/16						5/18			
EAST MAIN ROAD	NB–LT.	D	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~G~~	~~Y~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	F ~~R~~
EAST MAIN ROAD	NB	E,F	R	R	R	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	F Y
EAST MAIN ROAD	SB–LT.	A	~~G~~	~~Y~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	F ~~R~~
EAST MAIN ROAD	SB	B,C	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y	R	R	R	R	R	R	R	F Y
VALLEY ROAD	EB–LT.	G	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~G~~	~~Y~~	~~R~~	~~R~~	~~R~~	~~R~~	F ~~R~~
VALLEY ROAD	EB	H,J	R	R	R	R	R	R	R	R	R	G	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	F R
VALLEY ROAD	WB–LT.	K	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~G~~	~~Y~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	~~R~~	F ~~R~~
VALLEY ROAD	WB	L,M	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	G	Y	R	F R
PED. CROSSING VALLEY ROAD	N–S	P1,P2	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	W/FDW	DW	DW	DW	DW	DW	DW	DW	DW	DARK
PED. CROSSING VALLEY ROAD	N–S	P3,P4	DW	DW	DW	W/FDW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	
PED. CROSSING EAST MAIN ROAD	E–W	P5,P6	DW	DW	DW	DW	DW	DW	DW	DW	DW	W/FDW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	
PED. CROSSING EAST MAIN ROAD	E–W	P7,P8	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	DW	W/FDW	DW	DW	
DETECTOR			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			
RECALL			OFF			SOFT			OFF			OFF			OFF			SOFT			OFF			OFF			

NOTES:

1. FLASHING OPERATION PER M.U.T.C.D. SECTION 4B–18.
2. MAXIMUM 1 = NORMAL OPERATION
3. MAXIMUM 2 = NOT USED
4. PED. W/FDW UPON PUSHBUTTON ACTUATION ONLY.

ø1	ø2	ø3	ø4	ø5	ø6	ø7	ø8
							

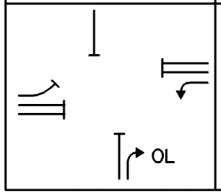
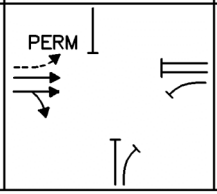
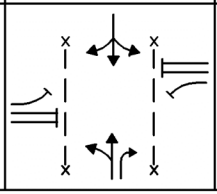
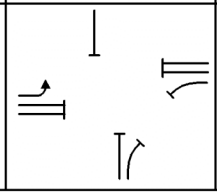
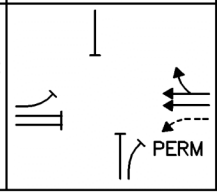
Example Sequence and Timing Diagram:

SEQUENCE AND TIMING DIAGRAM

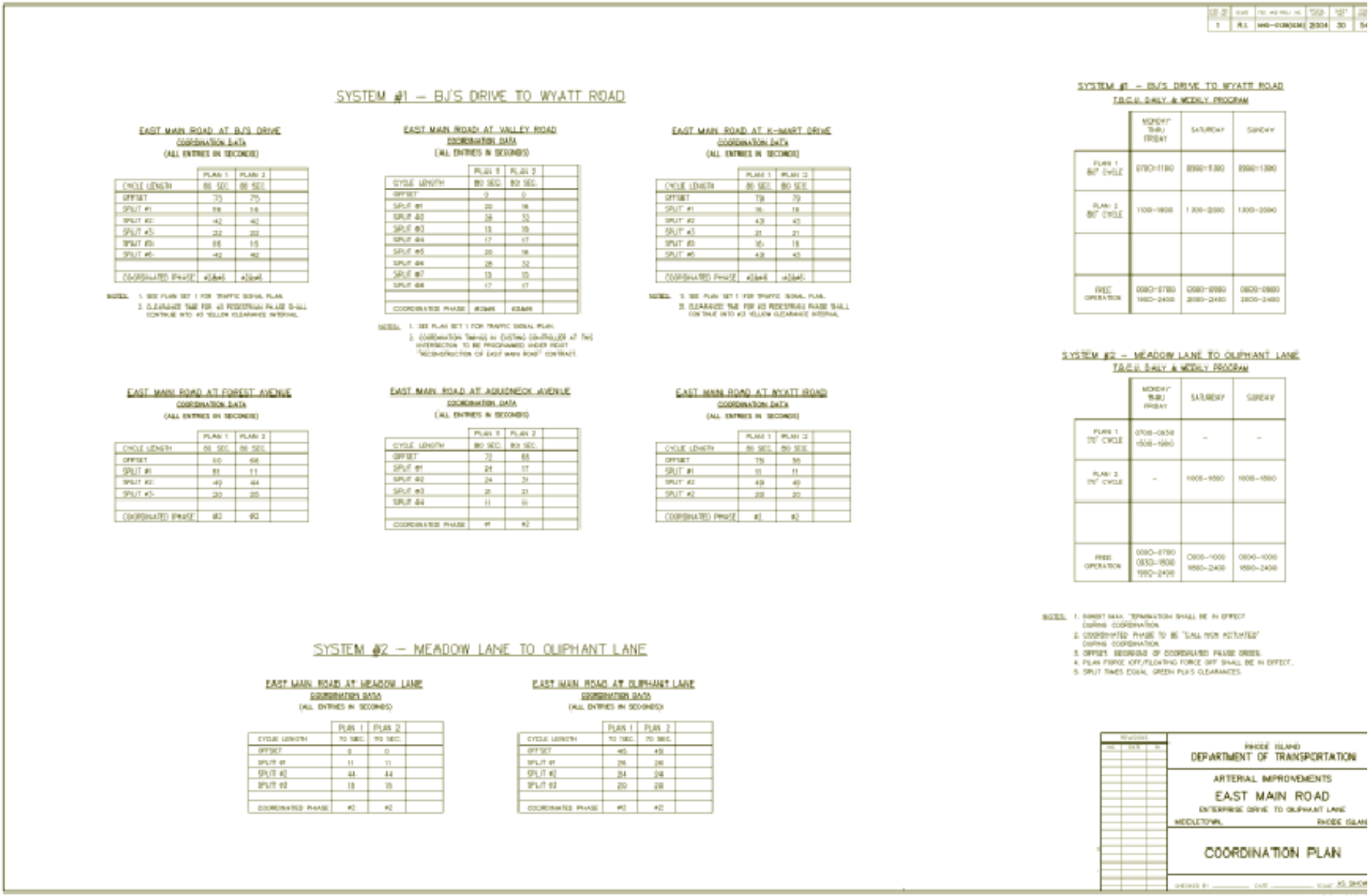
APPROACH	DIRECTION	HOUSING	ø1			ø2			ø3			ø5			ø6						FLASHING OPERATION
MINIMUM INTERVAL			5			10			6			5			10						
VEHICLE EXTENSION			2.2			2.8			2.8			2.2			2.8						
MAXIMUM 1			15			45			20			15			45						
MAXIMUM 2			15			45			20			15			45						
YELLOW CLEARANCE				3.5			3.5			3.5			3.5			3.5					
RED CLEARANCE					1.5			1.5			1.5			1.5			1.5				
PED. WALK/CLEARANCE									5/16												
EAST MAIN ROAD	NB–LT.	C	R	R	R	G	Y	R	R	R	R	R/G	R/Y	R	R	R	R				FY
EAST MAIN ROAD	NB	D	R	R	R	G	Y	R	R	R	R	R	R	R	R	R	R				FY
EAST MAIN ROAD	SB–LT.	A	R/G	R/Y	R	R	R	R	R	R	R	R	R	R	G	Y	R				FY
EAST MAIN ROAD	SB	B	R	R	R	R	R	R	R	R	R	R	R	R	G	Y	R				FY
MIDAS DRIVEWAY	EB	E,F	R	R	R	R	R	R	G	Y	R	R	R	R	R	R	R				FR
BJ'S DRIVEWAY	WB	G	R	R	R	R	R	R	G	Y	R	R	R	R	R	R	R				FR
BJ'S DRIVEWAY	WB–RT.	H	R/G→	R/Y→	R	R	R	R	G	Y	R	R	R	R	R	R	R				FR
PED. CROSSING EAST MAIN ROAD	E–W	P1–P4	DW	DW	DW	DW	DW	DW	W/FDW	DW	DW	DW	DW	DW	DW	DW	DW				DARK
DETECTOR			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK			NON–LOCK						
RECALL			OFF			SOFT			OFF			OFF			SOFT						

SEQUENCE AND TIMING NOTES:

1. FLASHING OPERATION PER M.U.T.C.D. SECTION 4B–18.
2. PERM = PERMISSIVE
3. OL = OVERLAP
4. MAXIMUM 1 = NORMAL OPERATION
5. MAXIMUM 2 = NOT USED
6. PED. W/FDW UPON PUSHBUTTON ACTUATION ONLY

ø1	ø2	ø3	ø5	ø6	ø4,ø7,&ø8
					NOT USED

Example Coordination Summary Sheet:



SYSTEM #1 – BJ'S DRIVE TO WYATT ROAD

EAST MAIN ROAD AT BJ'S DRIVE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	75	75	
SPLIT #1	18	18	
SPLIT #2	42	42	
SPLIT #3	22	22	
SPLIT #5	18	18	
SPLIT #6	42	42	
COORDINATED PHASE	#2&#6	#2&#6	

NOTES: 1. SEE PLAN SET 1 FOR TRAFFIC SIGNAL PLAN.
2. CLEARANCE TIME FOR #5 PEDESTRIAN PHASE SHALL CONTINUE INTO #3 YELLOW CLEARANCE INTERVAL.

EAST MAIN ROAD AT VALLEY ROAD
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	0	0	
SPLIT #1	20	18	
SPLIT #2	26	32	
SPLIT #3	13	13	
SPLIT #4	17	17	
SPLIT #5	20	18	
SPLIT #6	26	32	
SPLIT #7	13	13	
SPLIT #8	17	17	
COORDINATED PHASE	#2&#6	#2&#6	

NOTES: 1. SEE PLAN SET 1 FOR TRAFFIC SIGNAL PLAN.
2. COORDINATION TIMING IN EXISTING CONTROLLER AT THE INTERSECTION TO BE PROGRAMMED UNDER FIRST "RECONSTRUCTION OF EAST MAIN ROAD" CONTRACT.

EAST MAIN ROAD AT K-MART DRIVE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	79	79	
SPLIT #1	18	18	
SPLIT #2	42	42	
SPLIT #3	22	22	
SPLIT #5	18	18	
SPLIT #6	42	42	
COORDINATED PHASE	#2&#6	#2&#6	

NOTES: 1. SEE PLAN SET 1 FOR TRAFFIC SIGNAL PLAN.
2. CLEARANCE TIME FOR #5 PEDESTRIAN PHASE SHALL CONTINUE INTO #3 YELLOW CLEARANCE INTERVAL.

EAST MAIN ROAD AT FOREST AVENUE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	60	68	
SPLIT #1	11	11	
SPLIT #2	49	44	
SPLIT #3	20	20	
COORDINATED PHASE	#2	#2	

EAST MAIN ROAD AT AQUIDNECK AVENUE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	70	68	
SPLIT #1	24	17	
SPLIT #2	24	31	
SPLIT #3	21	21	
SPLIT #4	11	11	
COORDINATED PHASE	#1	#2	

EAST MAIN ROAD AT WYATT ROAD
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	80 SEC	80 SEC	
OFFSET	75	55	
SPLIT #1	11	11	
SPLIT #2	49	49	
SPLIT #3	20	20	
COORDINATED PHASE	#2	#2	

SYSTEM #1 – BJ'S DRIVE TO WYATT ROAD
T.O.C.U. DAILY & WEEKLY PROGRAM

	MONDAY THRU FRIDAY	SATURDAY	SUNDAY
PLAN 1 80" CYCLE	0730-1130	0900-1300	0900-1300
PLAN 2 80" CYCLE	1100-1900	1300-2200	1300-2200
FREE OPERATION	0000-0730 1900-2400	0000-0900 2200-2400	0000-0900 2200-2400

SYSTEM #2 – MEADOW LANE TO OLIPHANT LANE
T.O.C.U. DAILY & WEEKLY PROGRAM

	MONDAY THRU FRIDAY	SATURDAY	SUNDAY
PLAN 1 70" CYCLE	0700-0830 1500-1900	-	-
PLAN 2 70" CYCLE	-	1000-1500	1000-1500
FREE OPERATION	0000-0700 0830-1500 1900-2400	0000-1000 1500-2400	0000-1000 1500-2400

NOTES: 1. SUNSET MAX. TERMINATION SHALL BE IN EFFECT DURING COORDINATION.
2. COORDINATED PHASE TO BE "CALL FOR ACTUATED" DURING COORDINATION.
3. OFFSET RECORDED AT COORDINATED PHASE ORDER.
4. PLAN FORCE OFF/FLOATING FORCE OFF SHALL BE IN EFFECT.
5. SPLIT TIMES EQUAL GREEN PLUS CLEARANCES.

SYSTEM #2 – MEADOW LANE TO OLIPHANT LANE

EAST MAIN ROAD AT MEADOW LANE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	70 SEC.	70 SEC.	
OFFSET	0	0	
SPLIT #1	11	11	
SPLIT #2	44	44	
SPLIT #3	15	15	
COORDINATED PHASE	#2	#2	

EAST MAIN ROAD AT OLIPHANT LANE
COORDINATION DATA
(ALL ENTRIES IN SECONDS)

	PLAN 1	PLAN 2	
CYCLE LENGTH	70 SEC.	70 SEC.	
OFFSET	45	45	
SPLIT #1	26	26	
SPLIT #2	24	24	
SPLIT #3	20	20	
COORDINATED PHASE	#2	#2	

REVISIONS

NO.	DATE	BY

RHODE ISLAND
DEPARTMENT OF TRANSPORTATION

ARTERIAL IMPROVEMENTS
EAST MAIN ROAD
ENTERPRISE DRIVE TO OLIPHANT LANE
MIDDLETOWN, RHODE ISLAND

COORDINATION PLAN

CHECKED BY: _____ DATE: _____ SHEET NO. XX OF XX

Example Coordination Data Table: